



## Physical Sciences

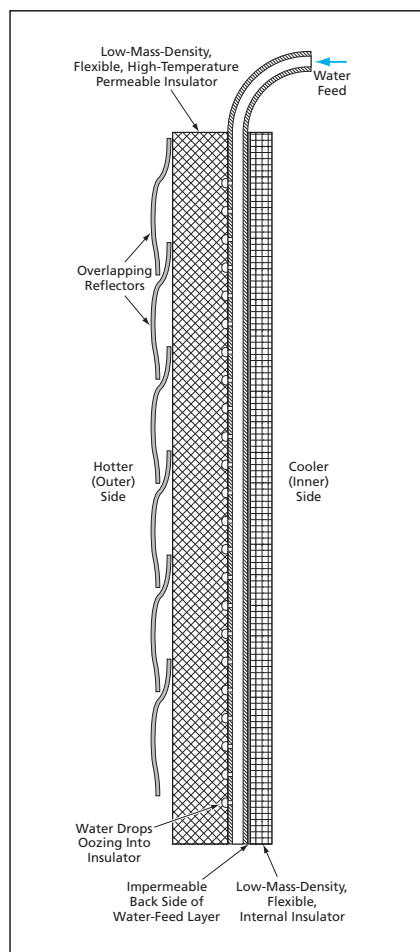
### Evaporation-Cooled Protective Suits for Firefighters

**In comparison with suits now in use, these could protect for longer times.**

*Langley Research Center, Hampton, Virginia*

Suits cooled by evaporation of water have been proposed as improved means of temporary protection against high temperatures near fires. When air temperature exceeds 600 °F (316 °C) or in the presence of radiative heating from nearby sources at temperatures of 1,200 °F (649 °C) or more, outer suits now used by firefighters afford protection for only a few seconds. The proposed suits would exploit the high latent heat of vaporization of water to satisfy a need to protect against higher air temperatures and against radiant heating for significantly longer times. These suits would be fabricated and operated in conjunction with breathing and cooling systems like those with which firefighting suits are now equipped.

A protective suit according to the proposal would include a water-storage and -distribution system that would cause the suit to "sweat" all over as needed. The quantity of water carried (typically a few liters) could be selected according to the expected task. If the water were carried in a slightly pressurized tank, there would be no need for a pump. The water-distribution system would include bimetallic-actuated valves that would regulate rates of flow according to the local temperatures in the suit. For example, it has been estimated that releasing water at a rate of 1 milliliter per second would be sufficient to prevent the surface temperature of the suit from exceeding 140 °F (60 °C) at an air temperature of 1,000 °F (538 °C), and a 2-liter supply of water would be more



**Shinglelike Outer Reflectors** would protect against radiative heating. Evaporation of water from the inner surface of a permeable insulating layer would keep the interior temperature much lower than the ambient air temperature.

than enough to provide this protection for half an hour. The adjustability of flow rates would also make it possible to protect against radiative heating for times longer than were previously possible.

For even better protection against both conductive and radiative heating, a suit according to the present proposal could include both a highly reflective outer layer as well as an evaporative-cooling sublayer system. Whereas the outer layers of some protective suits now in use have reflectivities of about 0.90, the proposal calls for a reflectivity of about 0.97. In one version, shown in the figure, the outer layer would consist of overlapping shinglelike reflectors (see figure), possibly made of thin copper plates coated with gold. The shingles would be individually attached to the suit so that they could slide over each other and motion would not be restricted. The water would be injected into, and would evaporate from the inner surface of a thick, permeable insulating layer, which is shielded by the reflective shingles. The shingles would be allowed to get very hot, but the wet sub-layer would remain much cooler, and water would be used up at a lower rate than would be the case if no reflective shingles were used and water were allowed to evaporate directly from a hot outer surface.

*This work was done by Leonard Murray Weinstein of Langley Research Center. For further information, contact the Langley Innovative Partnerships Office at (757) 864-8881. LAR-16245-1*

### Plasmonic Antenna Coupling for QWIPs

**Plasmonic antennas would be potentially superior alternatives to surface corrugations.**

*NASA's Jet Propulsion Laboratory, Pasadena, California*

In a proposed scheme for coupling light into a quantum-well infrared photodetector (QWIP), an antenna or an array of antennas made of a suitable metal would be fabricated on the face of what would otherwise be a standard QWIP (see figure). This

or any such coupling scheme is required to effect polarization conversion: Light incident perpendicularly to the face is necessarily polarized in the plane of the face, whereas, as a matter of fundamental electrodynamics and related quantum selec-

tion rules, light must have a non-zero component of perpendicular polarization in order to be absorbed in the photodetection process. In a prior coupling scheme, gratings in the form of surface corrugations diffract normally incident light to oblique an-